04. Relation analysis of road damage with excessive vehicles load on Kalianak road Surabaya

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Relation analysis of road damage with excessive vehicles load on Kalianak road Surabaya

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Abstract. Kalianak Road Surabaya is a strategic road. The volume of vehicles on Kalianak Road Surabaya is very high because there are many factories (industrial areas) along the road. Heavy truck or tronton type vehicles often pass this road, resulting damage to the Kalianak Road Surabaya. In this study, Dirgolaksono & Mochtar method [5] used to analyze the road damage. From result of research, mean of percentage of vehicle cause of road damage is truck/tank 2 axis equal to 34.42%. The relationship between EAL (Equivalent Axle Load) and road damage are related and affect each other. The biggest type of damage on Kalianak Road Surabaya is Distortion Profile which is 19.8% for phase I and 20.24% for phase II.

1. Introduction

Road conditions can affect the rate of the economy [6]. According to Otegbulu [7], damaged roads make the flow of goods, services and human transportation inhibited. In addition, it can also cause the operational costs of vehicles to be increased due to damage to the vehicle part as the effect of burden, bumpy road and perforated. Road damage is a condition in which the function and road structures are not able to serve the traffic above it optimally. In general, the damage is caused by planning and implementation errors [10, 11], patchy maintenance [12], bad drainage [10], and road user behavior [13, 14]. The behavior of road users such as class III road will be quickly damaged if passed by large truck type vehicles or vehicles that exceed the tonnage limit. Kalianak Road Surabaya is a strategic road. The volume of vehicles on Kalianak Road Surabaya is very high because there are many factories (industrial areas) along the road. Heavy truck or tronton type vehicles often pass this way. As a result every year there is damage in Kalianak road is like a hole and a puddle that endangers road users and ultimately can disrupt the economy in Surabaya. This research's purpose is to determine the cause of road damages possibilities, resulting from excess load, damages, and road repairs

2. Literature and Method

2.1. Road pavement planning principle

Principle of pavement planning by using:

a. The principle of repetitive load
   That is not based on the largest load that passes (ultimate load), but on the accumulated load is planned to pass.
b. The principle of fatigue (fatique)

Paved roads will be permanently damaged by design loads that exceed the fatigue limit of the material mixture, so at this stage the pavement life is exceeded. Planning limits of strain crack (tired/broken) and the magnitude of the repetitive load, meaning more and more loads passing, then the fatigue will occur quickly, let alone the repeated burden of greater weight will accelerate the process of fatigue of the material.

2.2. Determination of value of road damage by Dirgolaksono & Mochtar Method

Assessment of road damage using Dirgolaksono & Mochtar method [5]:

a. Damage Category I : Potholes. Based on the percentage of damaged area on the road segment under review with the provision of more 1 ft² (0.090 m²) hole area included in this type of damage [9].
b. Damage Category II : Alligator Cracking, Ravelling/Weathering, Profile Distortion.
c. Damage Category III : Block Cracking, Longitudinal Cracking, Transverse Crack, Rutting.
d. Damage Category IV: Flushing, Edge Distortion

2.3. Data collection stage

Primary Data:

- Visualization of the geometric condition of Kalianak road.
- Calculate the area of road damage by type along the Kalianak road and documented before and after the 99-day load.
- Doing traffic counting to calculate LHR.

Secondary Data:

- Topographic maps.
- Data on the number of Surabaya city vehicles.

2.4. Data processing stage

1. Entry survey data
   - Condition of the Road
     Entry for the condition and area of road damage in accordance with Dirgolaksono & Mochtar method, the road damage reviewed is equipped with photos of the damage that occurred along Kalianak road.
   - Traffic Counting
     Entry traffic counting is to create LHR data for damage points that are believed to be damaged by overloading.
2. Create daily traffic data from traffic survey results.
3. Calculating EAL.
4. Calculate the value of damage consisting of survey data I and survey data II and then calculated the difference calculation between survey I and survey II.

2.5. Statistical analysis

Phase determine hypothesis in this research there are two that is:

1. Determining the Hypothesis of Wilcoxon Signed Ranks Test
2. Determining the Paired T Test Hypothesis.
3. Calculation Phase

The result of traffic counting that has been processed then can get the value of EAL within 99 days, to then get the effect of the damage by using statistical test Wilcoxon Signed Ranks Test and paired T test. The statistical test of Wilcoxon Signed Ranks Test data used in this statistic test uses ordinal data, the data comparing road damage conditions between phase I (before) and second phase (after) surveys. The condition of road damage is obtained from the grouping of road damage value based on Dirgolaksono & Mochtar Method.

3. Results and Discussion

3.1. Road damage assessment

Kalianak road length 11.59 km, to facilitate the analysis is divided into 3 segments. Road damage data were obtained from the Kalianak road survey which is divided into two stages:

- Phase I : Survey of road damage by direct observation, to determine the initial damage.
- Phase II : after 99 days, survey of road damage by direct observation, to determine the final damage.

While the vehicle volume survey conducted on a normal day that is Tuesday, Wednesday and Thursday. The implementation of the survey was conducted on 14-16 June 2016 and 21-23 June 2016. In this study used Dirgolaksono & Mochtar. Observation the effect of road damage and the effect of road damage to traffic volume was tested statistically by using regression test method, and paired T test with significance level $p \leq 0,05$. From the largest increase in road damage for 99 days, occurred in STA 5 + 000 s.d 5 + 500 of 172.

3.2. Evaluation of traffic counting data and EAL

The traffic counting data consists of traffic data passing through Kalianak Road, as a whole. Starting from June 14 to June 16, 2016 and June 21 - June 23, 2016, the survey was conducted from 06.00 am to 12.00 pm every 15 minutes of recording to get more accurate results. In table 3, the largest vehicle volume of two-wheeled vehicles with an average daily volume of 2287 vehicles, but this type of vehicle is considered meaningless or does not contribute a large burden because this type of vehicle does not have the equivalent figure. While the value of EAL is the largest vehicle type 2-axis truck / tank with an EAL value of 254452.39. From table 1 also obtained the average percentage of vehicles causing road damage is the truck / tank 2 axis of 34.42%. While the second cause of damage is semi trailer truck and truck trailer of 33.27%.

Table 1. Average Percentage of Vehicle Causes of Damage

Information	Motorcycle Bicycle	Sedan, Jeep, Station Wagon	Small Bus	Bus	Truck/ 2 Axis Tank 3/4"	Truck/ 2 Axis Tank	Truck/ 3 Axis Tank	Truck/ Truck Trailer	Truck Semi Trailer
Number of Vehicle	2287	1430	79	91	1022	494	253	211	244
E	0	0.0004	0.2174	0.306	0.2175	5.2064	5	4.982	10.183
Interval	99	99	99	99	99	99	99	99	99
EAL	0.00	56.61	1707.46	2766.85	21999.04	254452.39	130232.89	104069.00	245980.55
Total	761264.79								
% Causes of Damage	0.00%	0.01%	0.23%	0.37%	2.98%	34.42%	17.61%	14.08%	33.27%

Source : the calculation results

3.3. Road damage relationship with EAL value

After the first phase survey and second phase survey and the value of EAL for 99 days. The value of the damage can be used to determine the effect of damage value that occurs along Kalianak road with EAL value. To determine the effect of damage with EAL value then analyzed by using statistical test regression test, and paired t test, with decision-making based on the probability of significance level $\alpha = 0.05$.

3.3.1. Regression test.

From the result of statistic regression test found the relationship between EAL and road damage expressed by equation:

$Y = 7838.1783X + 569287.0372$

with $R = 0.872460046$ $R^2 = 0.761186532$

R^2 approaches 1 (one) indicates that EAL and road damage are related and affect each other.

3.3.2. Paired T test.

Statistical test results using paired t test obtained $P = 0.001578336 \leq t = 2.91998558$ which means H_0 is rejected and H_1 accepted, because of the table results show $P \leq t$. From the results of statistical tests using statistical tests Regression test and paired t test concluded that there is a significant influence between EAL and road damage along Kalianak Road.

3.4. Values of damage and measures of damage prevention on Kalianak Road Surabaya.

In table 2, the results of the road condition survey in phase I and the phase II using Dirgolaksono & Mochtar method found that the damage of the type of Distortion Profile is the most damage in the Kalianak Road, which is 19.8% for phase I and 20.24% for phase II.

Table 2. Percentage type of damage

Category	Damage	Kalianak Road Surabaya	
		Phase I	Phase II
1	Potholes	16.20	15.91
2	Ravelling/Weathering	13.58	13.53
	Alligator Cracking	14.57	17.10
	Profile Distortion	19.80	20.24
3	Block Cracking	2.37	2.54
	Transverse Crack	11.46	10.12
	Longitudinal Cracking	13.09	11.85
	Rutting	8.92	8.71

Source : The calculation results

By looking at the percentage of road damage that occurred along the Kalianak road using Dirgolaksono & Mochtar, the biggest damage is road damage due to type distortion profile and how to solve this type of damage according to Road Maintenance Manual (No.03 / MN / 1983) by Bina Marga by way of patching of road surface structures.

4. Conclusion

From the results of discussion, can be taken some conclusions are:

a. The largest volume of vehicles crossing the Kalianak road is a two-wheeled vehicle with an average daily volume of 2287 vehicles, but this type of vehicle is considered insignificant or does not contribute a large burden to road damage because this type of vehicle does not have an equivalent number.

b. The average percentage of vehicles that cause road damage is 2-axis truck / tank of 34.42%. While the second cause of damage is semi trailer truck and truck trailer of 33.27%.

c. The relationship between EAL and road damage expressed by the equation:

$Y = 7838.1783X + 569287.0372$

with $R = 0.872460046$ $R^2 = 0.76118653$

From the value of R^2 indicates that EAL and road damage are related and affect each other.

d. Distortion / Release Profile type is the most damage type in Kalianak road, which is 19.8% for phase I and 20.24% for phase II.

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